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EXTERNAL MORPHOLOGY OF THE DUGONG

H. DEXLER AND L. FREUND

In continuation of our previous article in this journal on the physiology and biology of the dugong, we wish now to treat of its external morphology. Present knowledge of this subject is indeed considerably greater than that of its biology though it is still far from complete and particularly has the want of a good figure of the animal been felt. Kükenthal was keenly sensible of this and sought partially to remedy the defect by giving an excellent figure of a dugong embryo and its snout. It is our hope that the figures here given will at least in some degree make amends for this lack of illustrations, since they are from photographs taken by Dexler on the Australian coast during an expedition for the purpose of obtaining dugong material for scientific study, supported by the Gesellschaft zur Förderung deutscher Wissenschaft, Kunst, und Literatur in Böhmen. It is instructive also to compare these photographs with the first sketches of the dugong drawn from Nature by Dr. O. Finsch *(Illustr. Zeitung,* Leipzig, 1901, no. 3012). The description as well, is capable of improvement and amplification, for otherwise there would have been no object in obtaining the material.

As regards the size of the dugong, various measurements were made of several specimens killed and these measurements are here brought together in the following table.

Table of Measurements in Centimeters

No. and Sex	7♂	1♂	2♂	4♀	5♂	6♂	7♂
Total length	273	315	311	245	280	290	300
Greatest girth (hand's breadth behind flippers)				202	181	200	
Axillar girth						175	183
Breadth of caudal fin				77	82		77
Length of flipper				28	32	36	34
Breadth of flipper						20	22

No. and Sex	7♂	1♂	2♂	4♀	5♂	6♂	7♂
From eye to end of snout				18			
From eye to ear opening				15			
From anus to center of margin of tail				80	82		101
From genital opening to center of margin of tail				90	132		156
From navel to center of margin of tail					169		191
Interorbital width				21			
Width of snout				24	22		
Height of snout					17		
Depth of mouth cavity				10			
Palatal process (breadth: height)					7.4		
Extent of lung sounding (from tip of snout)					160		

From these measurements it is seen that the smallest specimen was a female, 245 cm. in length. The male animals obtained, measured from 280 to 315 cm. in length, and of these the two measuring 311 and 315 cm. respectively, were the largest of 25 dugongs captured. The published records of the size of these animals show some variation. Turner and Finsch have already pointed out that the older authors were wrong in placing the average length of the dugong much too high (*e. g.*, Brown, 20 feet), and indeed all the measurements examined show (*cf.* Raffles, Owen, Rüppel, Klunzinger) that the dugong does not exceed 3½ meters in length (see also Finsch). In this, Rapp (8 to 10 feet) and Fairholme likewise agree. The statement of Brehm, 3 to 5 meters, is thus somewhat exaggerated. The length of the female is generally given as slightly less, and in our specimen was 2½ meters (Owen, 2.23 m.; Klunzinger, 2.37 m.).

As to the color of the dugong, Finsch has previously written at some length, and has brought together the various expressions that have been applied to this elusive shade. His account and that of Gill appear to agree with our own observations, namely, that the dorsal surface is in general a light grayish brown to bright bronze-brown with a slight metallic shimmer, while the ventral side is white to bright gray. According to Finsch the younger animals are almost bright flesh-color. The color of the dugong of the Red Sea has been otherwise described (by Rapp, Rüppel, Brehm) as a dull lead-gray, the back and top of the head more greenish. The dugong embryos from Australia studied by Kükenthal were blue-black on the head and brown on the belly, and this shade became lighter in larger animals. Brehm likewise mentions dark longitudinal streaks which, however, Kükenthal did not observe. Preserved skins become much darker with age until they are nearly black (Krauss, Finsch).

The skin is in general smooth, almost shining (Rüppel, Klunzinger, etc.). In case of animals that have been lying on the shore for some time, the skin, particularly of the dorsal side, shows an unusual luster. On the back and on the sides of the body there are numerous scratches and scars. These run in all directions, intersecting one another, and often are very deep, giving the animal a peculiar appearance. According to Klunzinger the dried skins show only a few scars but numerous furrows. Krauss also refers to the numerous scars and believes that they are due to injuries from contact with the coral rocks. The back and sides of the body are thickly studded with Chelonobiæ and less numerous Balanus. Finsch and Brehm assert that the skin lies everywhere smooth and is wrinkled on the stomach only. According to Rüppel there are a few small longitudinal folds on the sides of the belly. On close examination, however, we find that the skin is really not smooth throughout, but that there are numerous furrows

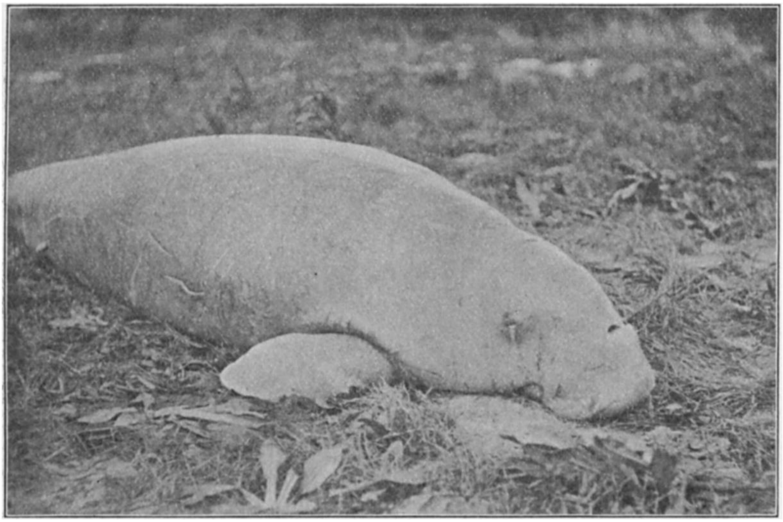

FIG. 1.— Australian dugong, antero-lateral view.

and wrinkles particularly on the head and fore part of the body. Thus many of them run parallel to each other from the corner of the mouth between the upper lip and the eye. Others pass below the eye, to radiate out from in front of it. Between the eye and the ear are many transverse folds which run toward the base of the flipper. The nuchal region is likewise traversed by wrinkles, among them a particularly prominent neck furrow. Many others are present in the region of the eye and will be described in connection with the latter. A deep surface furrow is present at the junction of the flipper with the body, while dorsal to this, a broad band of fine wrinkles varying in width passes to the eye. A few deep furrows traverse the neck ventrally and pass caudally into numerous longitudinal folds. The navel, genital opening, and anus lie in these longitudinal furrows which in the old males are deeper and more numerous. Behind the anus are a few transverse furrows on the side and these Kükenthal found in the embryos as well.

All over the body in little pits stand the hairs, some of which are living, others dead. They are short and slender yet stiff bristles, and may readily escape notice on account of their distance from one another (Finsch) but by passing the hand over the back of the animal they may easily be felt. They are more numerous on the back than on the belly (Klunzinger). Their distance apart according to Krauss is from 0.5 to 0.8 cm., though these figures can hardly apply to an adult animal. For Kükenthal in an embryo the length of whose back was 72 cm., found the intervals between hairs to be from 4 to 8 mm. Rüppel gives the distance in adults as 1 inch, Brown as 1 to 2 inches, and according to our observations it is not much greater. In an embryo 162 cm. long, Küken-

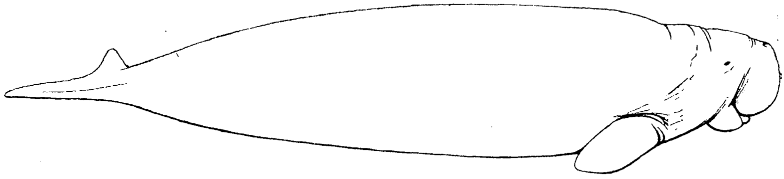

FIG. 2.— Dugong, lateral view. From sketch by Dexler.

thal found distances of from 2 to 3 cm. even at that early stage. This observer states particularly that there is a regressive development of the hairy covering in Sirenia such as he had shown previously to a greater degree in case of the Cetacea. Turner claims to have observed that the hairs were arranged in rows in an embryo dugong, but of such an arrangement we saw nothing. On the other hand, we found hairs, scattered to be sure, on the flippers and caudal fin where their occurrence is denied by Rapp, Rüppel, Brehm, and Finsch.

The body is in general spindle-shaped though not uniformly round as Rüppel and Brehm state. Anteriorly it diminishes in transverse diameter so that the head stands high, while posteriorly it decreases rapidly in vertical section till the body terminates in the horizontal caudal fin. The chest is somewhat trapezoidal in cross section in the middle, and toward the rear, with the decrease in width of cross section dorso-ventrally, it becomes flattened out laterally. The head is marked off by a shallow furrow at the neck. On the back the dorsal processes of the vertebræ are distinctly visible as low eminences all the way to the end of the tail as Owen has also shown. Rüppel noticed this feature in case of the tail only. The ends of the ribs also are evident along the sides of the breast.

The head of the dugong is the part showing the most modeling. The powerful curved upper mandible — compared by Brown to a nose of a very pronounced Roman type — the broad obtuse snout, and the nares situated on the summit of the head, give the latter a very characteristic appearance. We shall consider its peculiarities first through a study of the figures before going into the somewhat contradictory accounts in the literature of the subject. The head consists of a strikingly heavy skull and upper jaw and the small lower jaw almost lost to sight underneath it and separated from the cranium by the mouth cavity which slopes obliquely forward and downward. As before mentioned the head is marked off by a furrow at the neck. Ventrally, opposite the nape, a sharp clear boundary is made by a right-angled fold of skin. Seen from above, the head is longitudinally rectangular, considerably smaller than the neck, while the height of the head in side view is not greatly different from that of the neck. The top of the head curves sharply down on each side to the eyes. Anteriorly, toward the nostrils this arching is very slight, corresponding with the decrease in width of this region. The crown of the head is without hair, whereas the remainder of the upper portion is set with transparent bristles, from 4 to 5 mm. long, that arise from dark-colored pits. The sides of the upper jaw fall away rather sharply from the summit of the muzzle, downward and forward. From the nostrils, which are situated high on the head, the anterior portion slopes at first gently then bends strongly down to the mouth, to form the remarkable surface of the snout which is peculiarly modified on its lower portions. This area is broadly horseshoe-shaped, somewhat convex anteriorly, with the point directed a little obliquely forward and downward. It is from 22 to 24 cm. broad and 17 cm. high.

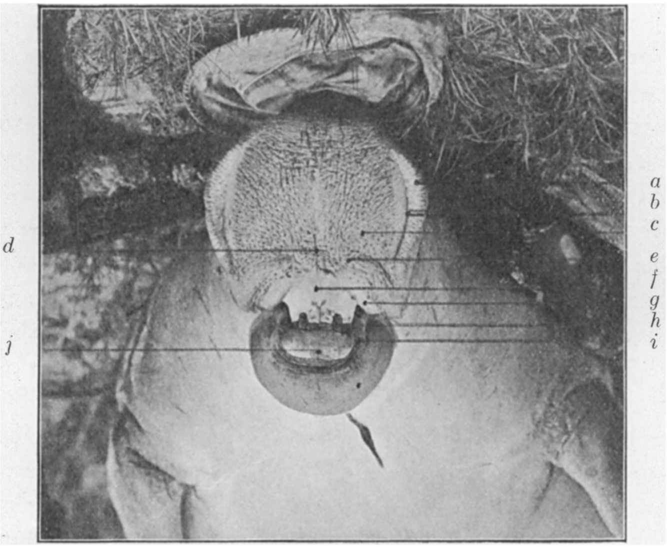

Fig. 3.— Dugong's head, anterior view. *a*, lateral fold; *b*, lateral furrow; *c*, central area; *d*, median furrow; *e*, lower limiting fold; *f*, mandible; *g*, intermediate fold; *h*, incisor tooth; *i*, chin fold; *j*, palatal process.

In the living animal the snout is soft and flexible and consists of a solid muscle mass traversed by fatty tissue, wherein the fiber bundles intersect in a complicated fashion as in the tongue. The skin of the snout is so very delicate and pliable that it may readily be gathered into a very narrow fold between the fingers. The surface of the snout is differentiated into (1) a middle portion, (2) its ventral posterior fold, and (3) the two lateral folds. The middle area is of the shape of a broad horseshoe. On its lower part there is a sharp median furrow which becomes lost ventrally in the gums, and likewise disappears in the dorsal third. The anterior half of this furrow is much shallower than the posterior. The entire surface is striated with numerous wrinkles which can be seen to have definite courses. Anteriorly, curves predominate whose convexity is forward while posteriorly there start on each side of the median line numerous wrinkles, at first parallel with one another, that radiate out towards the sides and, running forward, cross those first mentioned. On the folds thus produced stand thick short bristles. Dorsally the median surface of the snout passes into that of the general integument of the anterior dorsal region.

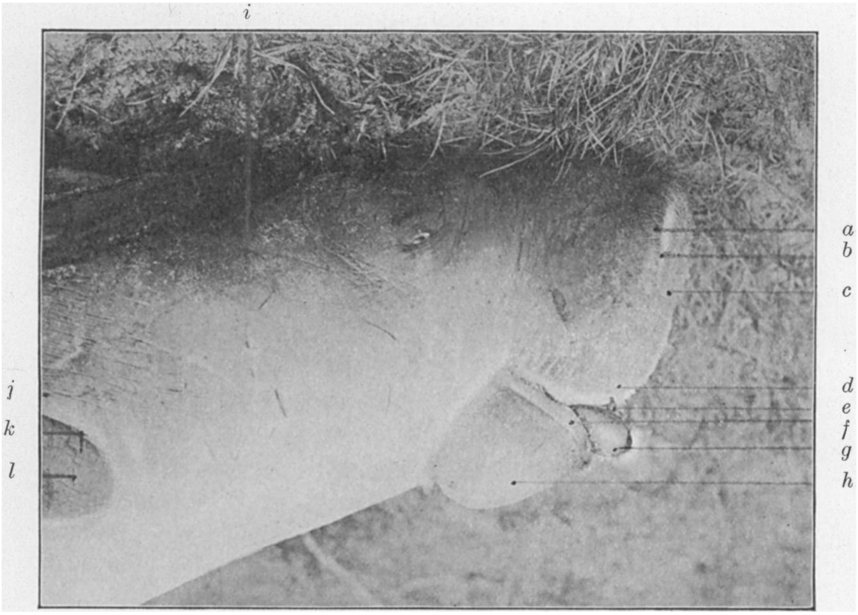

FIG. 4.— Dugong's head, lateral view. *a*, lateral fold; *b*, lateral furrow; *c*, central area; *d*, mandible; *e*, incisor; *f*, chin fold; *g*, palatal process; *h*, chin; *i*, ear; *j*, fold at the flipper; *k*, furrow at the flipper; *l*, flipper.

The demarcation of this middle area posteriorly is effected on both sides by a low broad fold which is crossed by the median furrow but begins at some distance from it and, becoming better defined laterally, passes downward and backward toward the corner of the mouth. Then on both sides it passes into the side fold of the middle area. Opposite the mandible, relatively opposite the gums, the lower fold becomes greatly enlarged though in the figure this feature does not appear since the flabby snout of the animal as it lay on its back, has sunken down. Nevertheless there is visible in this position an intermediate fold on both sides which fills the space between the corner of the mouth, the lower fold, and the mandibular process. The posterior limiting fold is likewise thickly set with the bristles previously mentioned. The middle fold, particularly toward the furrow, also shows these stiff, backwardly directed bristles.

The lateral folds are comparatively small and are separated from the middle area by a deep indentation. In the figure, these furrows gape apart on account of the depression of the snout. Numerous transverse wrinkles that intersect on the inner and outer sides, as well as an abundance of bristles along the borders are present on these lateral folds. They begin rather well up toward the dorsal part of the snout, and with a gentle lateral sweep, enclose the middle area and with a strong curve pass posteriorly toward the corners of the mouth. Here they merge with the posterior fold and at the same time the limiting furrow becomes very shallow. Beneath the snout and completely hidden by it when in the normal position, is the mandibular process covered by the gums. In the male this process bears on each side a short but stout incisor. The gum has a median anterior groove. Below the end of the mandible and the points of its projecting teeth is a strong firm palatal process that consists of solid fibrous tissue and reaches beyond the incisors. It is about twice as wide as thick (7 cm. to 4 cm.) and with its rounded anterior end bears a certain resemblance to the tip of a tongue. It is not retractile and is clearly visible between the jaws even when the latter are closed. From the fact that the furrows made in the sand by the dugong in grazing are of the same width as these palatal processes, it may be concluded that they play a part in the taking of food.

The shortened lower jaw is directed diagonally downward and extends backward with a breadth corresponding to that of the narrow mandibular cavity which is but 10 cm. deep. The anterior portion of the lower jaw is narrow and becomes rounded at the tip so that not only is it well set off from the neck but the angles of the mouth are also strongly drawn in. The transverse diameter of this chin-like projection is considerably greater than its length.

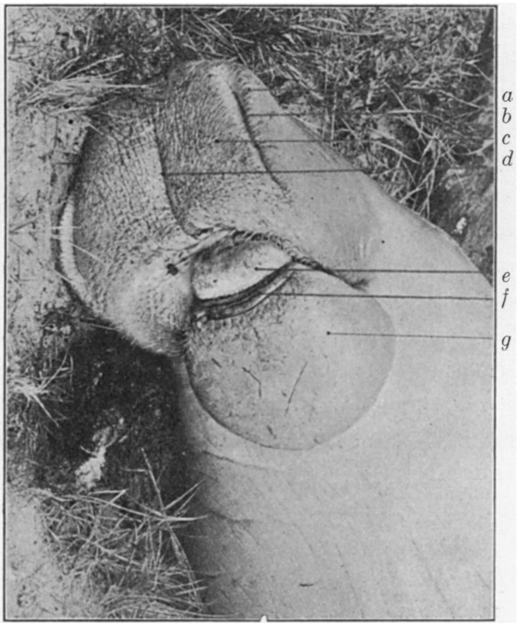

FIG. 5.— Dugong's head, ventral view. *a*, lateral fold; *b*, lateral furrow; *c*, central area; *d*, median furrow; *e*, palatal process; *f*, chin fold; *g*, chin.

The greatest length is in the plane of the mouth, for as is seen in profile, the outline of the chin starting from its origin at the neck, constantly recedes from the mouth till it bends down again to the tip of the jaw. The greatest transverse diameter is about in the middle between the corners of the mouth, along the line marking the origin of the chin from the neck, for the line defining the chin posteriorly is bent down on each side toward the corners of the mouth, like a pair of tongs. Along the margin of the mouth on each side of the lower jaw is a low narrow ridge which is marked off by a slight furrow from the rest of the chin. This ridge as well as a broad adjacent strip of the chin is thickly set with short fine bristles. The remainder of the surface of the chin bears coarser and more scattered bristles each of which springs from a small dark pit, just as in the case of the fold at the edge of the mouth near the palatal process.

In reviewing the literature on this subject we will first consider the account given by Rüppel. Contrary to our observations, he states that the long median furrow of the snout is bifurcate ventrally so that its form is that of an inverted Y. By this bifurcation, this portion of the snout is divided into three parts, the two upper of which belong with the nose while the small lower triangular part forms the upper lips proper, directed toward the inner surface of the mouth. It is of course obvious that the long vertical furrow spoken of by Rüppel is identical with that described by us. The bifurcation which, as our description shows, has nothing particular to do with the median furrow, is the bow-shaped depression formed by the snout proper and the palatal process. The small three-cornered portion below is the palatal process, which of course has no connection whatever with the lips. Rapp speaks in only a general way of the Sirenian snout. He states that the upper jaw ends anteriorly in the form of a flat blunt disc richly provided with nerves, that perhaps functions as an organ of taste; and further, that in the case of the dugong particularly, the "lips" are very thick and they as well as the corners of the mouth toward the inner side of the cheeks bear thick stubby bristles. Krauss makes no mention of the median furrow of the snout but describes the side folds which Rüppel omits. Both authors give detailed accounts of the distribution of hair on the snout. Krauss, however, correctly describes the palatal process and the fold at the edge of the lower jaw. Brehm and Finsch make mention of the head in a few words as does also Owen who considered its peculiar form to be especially adapted for the taking of food. Turner gave an extended account of the head of an adult female dugong but a comparison of his figure with ours shows that the preservation of his specimen with dry salt must have been very poor for it is greatly shrunken and out of shape. In consequence, the description based on this specimen can be only partially followed. For the median furrow is brought into connection with the furrows between the middle area and the posterior limiting folds as if it were bifurcate. The side folds end in a point posteriorly and are not continued into the posterior fold, which instead comes from the lateral portions of the middle area (Figs. 3, 5). Turner describes the greatly shrunken palatal process in his specimen as "middle lip (mesial process)" notwithstanding that it has no genetic connection with the lips. The middle area, on account of its being cut by the median furrow, is misleadingly called "lateral lips," so that in considering the homologies of the parts mentioned, it is necessary to take into consideration the probable shrinkage that they have undergone.

Of particular interest, naturally, are the embryological conditions as pictured in Kükenthal's sketches of a freshly preserved fetus. These sketches are much more satisfactory than the figures of the fetus given by Turner. In all the embryos the deep median furrow of the middle area is apparent. In his fourth stage, Kükenthal was able to make out a shallowing of this furrow in the region of the lip. From the fact that this portion of the furrow was lacking in Turner's figure of the adult, Kükenthal concluded that a fusion had here taken place between two originally separate portions in such a way that the two lateral parts of the upper lip had become united medially. In further support of this view, he cited Rüppel's figure, which as we have shown above is to be otherwise interpreted and is thus unavailable as evidence on this point. In our specimen the median furrow extended to the gum, and, since Turner's figure is untrustworthy, it can hardly be held that the two portions of the middle area are united at the posterior part of the furrow. At the same time we do not wish to contest Kükenthal's conclusion that the snout of the dugong, which in the adult is rather simple, has become like that of the manatee through a division into a median area and two lateral areas and that thus the manatee's snout is phylogenetically the older. For with this conclusion we are in hearty sympathy. This third median portion is to be found at the upper end of the median furrow as indicated by its upper bifurcation in a fetus of 72 cm. (Kükenthal), and an almost horizontal bifurcation in a fetus of 162 cm. in length (Turner). At an early period the two lateral folds are formed and are marked off in the embryo by a lateral furrow which is wanting in the adult, or is apparent in certain places only (Kükenthal). The side folds, which at first converge dorsally in the embryo, later become parallel, and finally in the adult become divergent above. The growth in breadth of the middle area is correspondingly greater in its upper than in its lower portion. The two posterior limiting folds of the middle area appear to be formed later. They are figured by Kükenthal from an embryo 162 cm. long. In the embryo the surface of the snout is marked off into little spaces with a beautiful regularity and from the center of each knob-like space rises a hair. The form of the palatal process and of the lower jaw in the embryo is not greatly different from that of the adult.

A short distance above the snout are the blowholes. These are two almost circular openings, close together and directed obliquely upward and forward on the muzzle. Owen characterizes their high dorsal position on the curve of the intermaxillary as one that is very advantageous for breathing. In our figures the nostrils are open, as usual in dead specimens. When the nostrils are closed, the muzzle is arched forward and slightly rounded. In our specimen we found nothing that might be called a valve-like structure, such as Rüppel and Turner mention, but this subject we have treated at length in our previous paper as regards both the dugong and the manatee (*Amer. Nat.*, vol. 40, pp. 49–72).

The eyes are situated on the side of the head, 18 cm. behind the tip of the nose in specimens of average size, and are about equidistant from the end of the snout and the corners of the mouth. They are visible through a narrow spindle-shaped opening that slants obliquely upward, and is 12 mm. long (Owen also). The eyelids are thick and tumid, and only feebly movable up and down; they are provided with a contractile muscle, the musculus orbicularis oculi. At the anterior corner the nictitating membrane is clearly visible (*cf.* also Rapp and Owen). There is no trace of eyelashes although Brehm speaks of them regardless of Rüppel's correct assertion that they do not exist. The bulbi are small and nearly spherical, though not egg-shaped as Brehm states. The iris and choroid layer are black-pigmented so that the whole eye appears dark.

In the region where the head passes into the neck, there is on each side of the former, at the end of a transverse series of neck furrows, the small ear opening. This is in a scarcely noticeable depression of the skin about 3 mm. in diameter, at about the same level with the eye and some 15 cm. behind it. There is no external ear and Turner found none in the embryos.

The external form of the two pectoral appendages, which arise not far from the head toward the ventral side of the body and project laterally, has been rather exhaustively treated in a work on their osteology by Freund. It remains to say, however, that the flippers are usually directed backward along the sides of the body, so that a thick fold arises above the furrow at the insertion. The upper surface is darker than the lower. The absence of hair on the flippers has already been mentioned. In the adult animal, the extreme length of the flipper is not over 32 cm., and the greatest breadth is 20 cm. or a trifle more.

The mammæ are short, hard, cone-shaped structures as thick as one's thumb. They are situated, one on each side, in the axillary region, behind the furrow of the flipper, as Owen and Rüppel also state, and are seen well from the ventral side. According to Owen, their bases in the case of a female specimen were about the size of a shilling, and they rose about one half an inch above the surrounding surface. Turner found no trace of mammæ in an embryo 162 cm. long.

As to the rest of the body there is but little to be said on account of the few peculiar characters it possesses. In the middle of the belly is the navel and 40 cm. behind it is the preputial opening or the vaginal furrow as the case may be. The latter is a slight cleft about 10 cm. long (*cf.* Klunzinger also) and is hardly to be differentiated from the anus. It lies slightly nearer the middle of the tail — 90 cm. (100 according to Klunzinger) — than the penis which is from 132 to 156 cm. distant from the navel. On these points Bischoff has published some observations. The anal opening and the vagina are closer together than are the penis and the anus. In animals that have been dead in the nets for some time and in which decomposition has begun, the penis is usually prolapsing. It is covered by an unpigmented skin and ends in a conical point with two large lateral lips.

The caudal portion of the body consists of a horizontally flattened fin, with a very slight indentation at the posterior margin. Its breadth is from 77 to 82 cm., and on this point Raffles and Owen also agree. There is no indentation in the shape of a half moon such as Rapp, Rüppel, and Brehm mention, but the posterior margin is feather-edged and often is considerably torn. According to Owen the tail is relatively larger than in the whales, and this he explains as due to the frequent necessity for coming very quickly to the surface for breath while feeding.

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